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Strategic Local Manufacturing Supplier Development Roadmap as a Decision Support Tool

M Vermeulen, GA Oosthuizen*

Department of Industrial Engineering, Stellenbosch University, Stellenbosch, 7600, South Africa

Abstract

Local manufacturing suppliers are critical to a country's economy and to ensure sustainability. In order to address all key areas for developing a local manufacturing supplier (LMS) from the informal- to the formal economy a strategic approach is required. A systematic literature study was conducted to establish the theoretical foundation. The conceptual roadmap was validated using case studies and the key elements, sequence of development phases, types of development projects and the role each stakeholder plays along the development of local suppliers were evaluated. This holistic roadmap for developing a LMS, as a strategic decision support tool can assist the end user to make informed decisions of the current maturity level and to determine the most appropriate LMS to develop. The roadmap further establishes a clear prioritised action plan relative to its maturity phase.

Keywords: Local Manufacturing, Supplier Development, Value creation

1. Introduction

Local manufacturing suppliers are the backbone of modern industrialised society, as it always has been cornerstone to the world's economy. The informal economy is the part of an economy that is neither monitored nor taxed by government. Therefore, governments are re-establishing policies to encourage larger companies to support the development of informal economy suppliers to integrate into the formal part of the economy, whereby the activities of the supplier are included in a country's gross domestic product (GDP). These new preferential procurement policy

* Corresponding author. Tel.: +27 (21) 808 9531; fax: +27 (21) 808 4245
E-mail address: tiaan.oost@gmail.com

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framework agreements, instituted for state owned entities, calls for further stringent adjudication processes, during tender stages to ensure tenders utilise a large local supplier base. The challenge however comes from the perceived lack of capability and competence of local suppliers to conform to the necessary quality and technical requirements of larger companies' specifications. Organisations are also faced with pressures from communities in which they intend to invest, while contributing to the sustainable development of their investment destinations. At the same time organisations further struggle to clearly identify the current maturity levels of their suppliers in order to determine where to focus their development initiatives. In addition, there is no holistic roadmap for developing local manufacturing suppliers that companies can utilise. Thus, a solution for sustaining and promoting the development of local suppliers from the informal base of the pyramid (BoP) to the formal economy, while ensuring the sustainability of the organisation operating within the environment, needs to be established.

1.1. Defining Local manufacturing supplier development

In Africa *local* is often misconstrued with historically disadvantaged individuals. Another misperception is the assumption that geographic position constitutes *local* suppliers. Kaiser [1] conducted a study for the World Bank in the mining industry across Western and Southern Africa. The study found that there are three elements constituting local suppliers namely; (1) the level of participation of the supplier in its local vicinity or country (whether the goods or services are supplied or manufactured locally), (2) The level of participation of local citizens in the company (3) and the geographical location of the company. From this definition highlights that a *local supplier constitutes a company that is majority owned by Local participants, manufactures goods locally, procures goods locally and supplies goods locally. Locally, therefore remains a geographical spaced distance although the constituents of the company determine whether it is local or not.*

Dodge and Rabbins [2] and Hanks, Watson, Jansen, and Chandler [3] established that the life cycle of SMEs pass through 3-4 generic phases which follow a basic S-shaped curve through the various development stages. These Phases are (1) start up or formation, (2) Early growth or Expansion, (3) Later growth or Maturity and (4) Sustainability or Diversification. Van Montfort [4] conducted a study on the successful life cycle characteristics of SME's and found that four prominent life cycles exist. In each life cycle there are certain factors that need to be addressed before progressing to the next stage when following a distinctive growth pattern. It is shown that the life cycle starts from an initial idea/concept through to a growth/expansion phase and ending as a sustainable business with various challenges through each stage.

1.2. Relevance of local supplier development

Porter and Kramer [5] argue that organisations are doing a lot to improve the societal and environmental consequences of their activities, but there is still so much to do. The reasons why the organisations do not optimise their efforts are mainly that they see business and society as two independent entities; and secondly organisations look at corporate social responsibility (CSR) in generic ways instead of in the context of shared value strategies. *CSR can be much more than a cost, a constraint or a charitable deed – it can be a source of opportunity, innovation and competitive advantage* [5]. Jack Welch [6] believed social responsibility begins with a strong, competitive company. A sustainable competitive company does not only pay taxes that provide for important governmental services, it also creates excellent infrastructure and reinvests in the social development of its people. In order to start the skills development of local suppliers from informal economies the people first need to be healthy and educated. The informal base of the pyramid (BoP) represents the largest (5 billion), but poorest (live on less than US$ 2.50 per day) socio-economic group [7]. These people should receive basic needs and basic services to survive. The BoP was first introduced in the work by Prahalad and Hart [8] and since then there have been considerable attempts to develop local value creating suppliers. In theory, organizations targeting this segment operate under the proposition of shared value creation, which suggests that creating more value for the BoP creates more value for the venture [7]. Therefore, in order to address all key areas to assist and manage the development of a local manufacturing supplier (LMS) from the informal BoP to the formal economy, a strategic approach is required. A framework to establish a holistic roadmap for developing a LMS will be developed as a strategic decision support tool. This roadmap should

assist the end user to make informed decisions of the current maturity level and to determine the most appropriate LMS to develop from a group of suppliers.

1.3. Short falls of local suppliers

The lack of sustainability efforts in SMEs is attributed due to the inherent characteristics of SMEs [9]. SMEs often lack the awareness, expertise, skills, finance, and human resources to build the required changes for sustainability within the organization [10]. Hillary [11] identified barriers and drivers for the environmental management system for SMEs. From the above research the differentiation can be made between the inhibiting factors, or as Hillary [11] stated, *barriers*, in starting up a local SME and factors relating to sustaining a local SME. Figure 1 illustrates the relationship between these two factors in terms of increasing competence and capability (representing the "Ecosystem" requirements) and increasing Sustainability (representing business opportunities/constructs to ensure sustainable business growth).

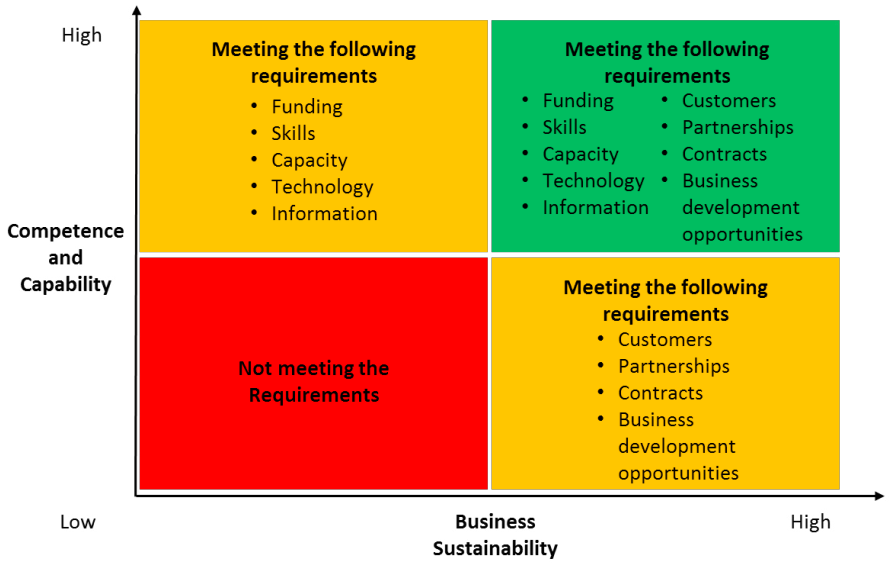


Figure 1: Relationship matrix between Sustainability and Competence & Capability factors when meeting certain key requirements

2. Research methodology

This research study represents a strategic local manufacturing supplier development roadmap as a decision support tool. The development of the roadmap entailed a systematic literature review of current local manufacturing suppliers' challenges, development requirements and current support structures to assist their development.

The necessary requirements and strategies from a company's perspective to develop LMS was investigated in conjunction with the policies and strategies of the governments to promote local supplier development. During the systematic review, research from the various fields of the topic were combined with current governmental policies, current supporting structures, case studies, interviews and the author's own industry experience to establish a theoretical framework as roadmap.

Thereby, this conceptual LMS development framework could be validated with three case studies in industry to determine if all constructs created correlate to the practical application thereof. After each case study, the conceptual framework was re-evaluated to incorporate further enhancements to ensure the final framework included all necessary decision support tools. For ease of reference, the final case study is represented in this paper for the validation of the framework.

Once the final LMS development roadmap with decision support tools was established, it was vetted through feedback from subject matter experts. Feedback from industry related personnel regarding the effectiveness of the tool and concluding results of the final strategic LMS development tool were made.

3. Roadmap development and validation

The process in developing a LMS development framework involves analysing the current inhibiting factors for local supplier development, segmentation of these factors into categories, determining the requirements to overcome each of the inhibiting factors/categories and mapping these solutions in a sequential (chronological) manner interlinking and identifying all interdependencies between stakeholders. A framework set out in this way will determine the fundamentals required in developing local suppliers through a systematic process by taking into consideration all value chain challenges throughout its life cycle. From the literature review and analysis of case studies conducted it was established that two main categories for the development of LMS exist namely; capability building and supply and demand (Sustainability). The key developmental elements identified, from the case studies and literature, for an LMS to fulfil is summarised as follows:

- **Infrastructure** - Necessary equipment, tools, technology etc.
- **Economic** - Business opportunity, manufacturing readiness, business administrative functions etc.
- **Location** – Capacity, physical floor space or land, proximity to business etc.
- **Social** - Basic needs of surrounding community (education, security, Healthcare etc.)
- **Competitiveness -** Quality of goods/services, performance measurement systems, continuous improvement culture, Sustainable Profit and Market Growth, integration into greater procurement value streams.
- **Competence** - Basic understanding of business, access to skill development for the LMS etc.

As illustrated in figure 2 four main phases exist during the development of the LMS. These phases can be identified as (1) social and educational, (2) infrastructure and technology, (3) business security and (4) longevity and integration. The social and educational category ensures the required skills and social well-being of the LMS are present to be able to achieve the basic level of support to the LMS. The objective of the infrastructure and technology phase ensures that the supplier achieves all necessary business structure to support it in complying with the end users requirements. The business security phase involves making sure that the supplier is at the correct manufacturing readiness level and can comply with the necessary requirements. The longevity and integration phase ensures that the supplier can maintain its competitiveness by implementing the necessary performance measurement systems and integrating it into the end users values stream to ensure its sustainability.

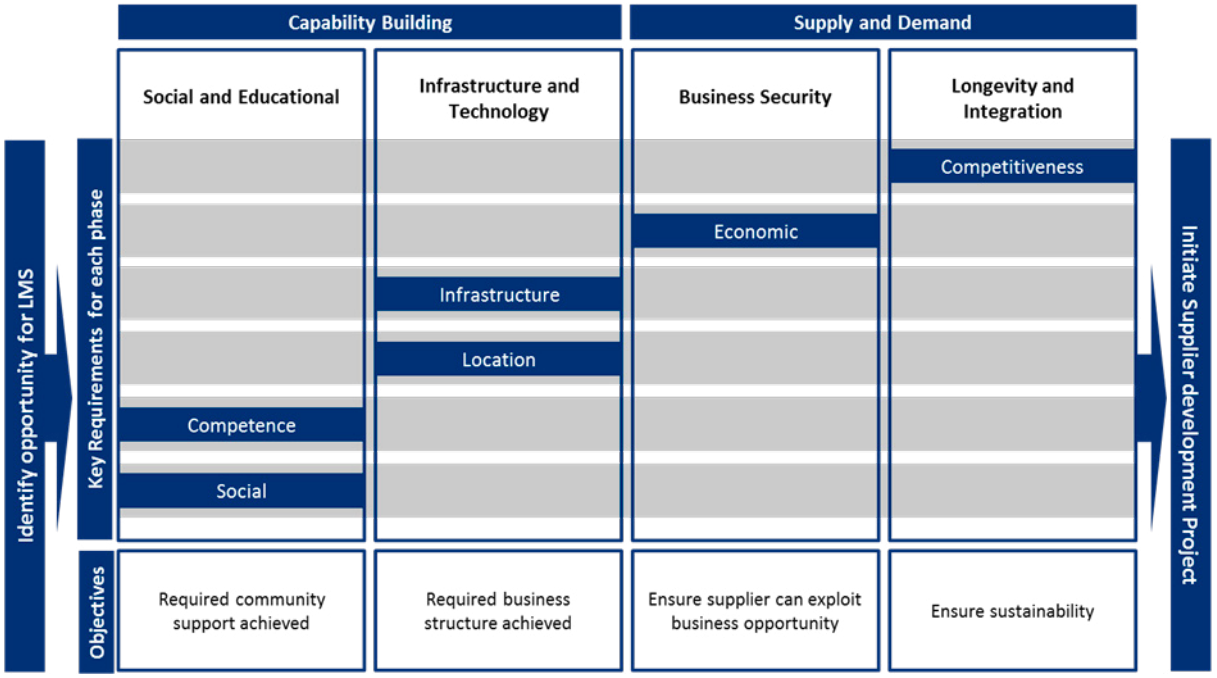


Figure 2: Holistic Local Manufacturing Supplier Development Framework

A mathematical model calculates the position of the LMS along the roadmap relative to the end users requirements and the LMS's current capabilities, which constitutes the inputs into the model. In order to create quantifiable conformance to each requirement of various suppliers, a scoring continuum with clear definitions is required for each criteria linked to a weighted metric. This will represent the importance for each supplier to conform to the relevant requirement. Each requirement is assigned a level of compliance, based on a continuum created, to represent the required conformance. Each criteria was given a weighting (as a percentage) to represent its overall importance within each category. The sum total percentage for each criteria assigned under each key element (social, competence, location etc.) may not exceed 100% as the weighting is relevant to the total amount of criteria under each key element. As example table 1 demonstrates the above mentioned scoring technique using the example of the Social criteria under the first phase of the LMS development road map (Social and Educational).

Table 1: Typical representation of criteria scoring from model inputs (for illustrative purposes only)

Social Element	**Required level (1-5)**	**LMS current level (1-5)**	**Weighting (0-1)**	**LMS Conformance**	**Annual Investment required for LMS to comply**				
Societal Needs					Year 1	Year 2	Year 3	Year 4	Year 5
Access to Health and Welfare	3	2	20%	0.13					
Housing	4	2	15%	0.08	R 150 000	R 150 000		R 150 000	
Security	3	3	15%	0.15					
Utilities									
Water	4	3	20%	0.15					
Electricity	4	4	20%	0.20					
Roads and transport	3	3	10%	0.10					
Total Compliance of LMS				**81%**					

By utilising the equations below, the total compliance of the LMS can be calculated. These equations are utilised in the model to determine the compliance level for a LMS in each of the key elements illustrated in figure 2 of the road map.

$$\sum_{j=1}^{6} \sum_{i=1}^{n} Wij = 100\% \quad (1)$$

$$Xij = \sum_{j=1}^{6} \sum_{i=1}^{n} \left(\frac{Cij}{Rij}\right) * Wij \quad (2)$$

$$Yj = \sum_{i=1}^{n} Xij \quad (3)$$

Rij represents the required level for LMS, *Cij* the current level for LMS, *Wij* is the weighting assigned to criteria, *Xij* the conformance score of LMS for criteria *i* within key element *j* with i ϵ(1,2,...n), j ϵ(1,2,...6). Yj represents the total compliance score for the LMS under key element *j* with *j* ϵ(1,2,...6). For each criterion under the various key elements the investment required were identified.

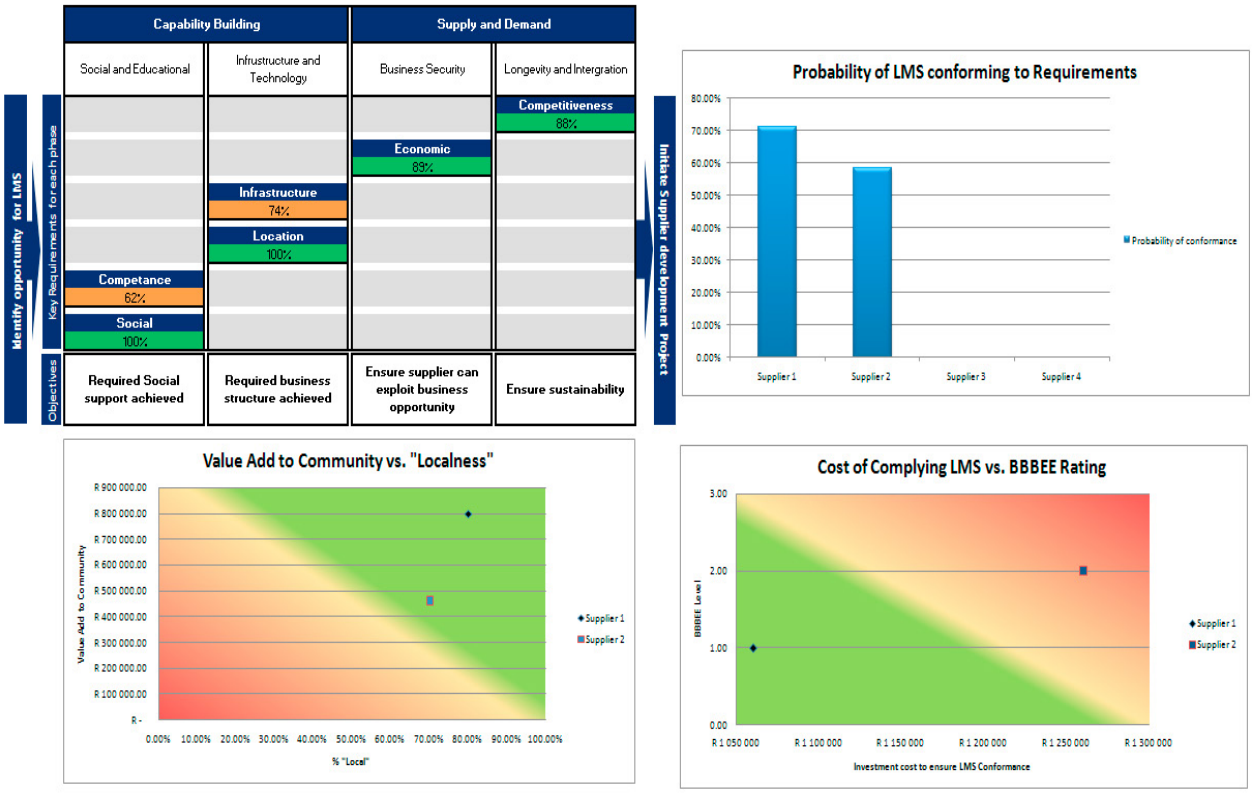
After the compliance of the LMS to each criterion could be calculated an action plan was established to determine the focus areas required for the development of the LMS. The outputs to the model include; an action plan to develop the LMS (detailing which requirements the LMS needs to be developed on, with suggested possible funding structures or support); heat maps illustrating the comparison of various suppliers based on the investment vs. reward (BBEE and value add to local community), the calculated position of the LMS on the development road map and a project management plan for developing the supplier.

3.1. Validation analysis of Howden Africa case study

In October 2015, Howden Africa embarked on a supplier development project to further increase its Broad-Based Black Economic Empowerment (BBBEE) rating. The project first involved identifying an opportunity for a local supplier. The supply chain department was tasked to identify an opportunity for a local supplier and then to adjudicate the various possible suppliers to select the most appropriate one. After a categorised procurement spend analysis, it was found that the top 5 opportunities to achieve this included, manufacturing of heat exchange plates, ventilation ducting, gas cleaning, electrical control and instrumentation and bearings.These categories were then assessed to determine the required skills, competency levels required and possible local suppliers. From this analysis it was found that the cages used to support the filter bags in the gas cleaning products was the best product to outsource to a LMS. Two local suppliers were considered for the opportunity. Due to confidentiality concerns, their anonymity need to be preserved and will be referred to as supplier 1 and supplier 2.

The supply chain department of Howden Africa conducted detailed investigations at each suppliers' premises to establish their current capabilities in terms of manufacturing, quality assurance processes and current equipment. From the evaluation, it was established that Supplier 1 was the most competent supplier, as they already possessed some knowledge of the product. To ensure that Supplier 1 could meet the technical requirements of producing the cages, Howden Africa offered training to a number of the artisans at its training facility for duration of 4 weeks. It was found however that Supplier 1 was struggling with their cash flow as most of their customers were only paying them after sixty days. Howden Africa structured an interest free 2-year loan agreement to Supplier 1. The results of the model illustrating the conformance of each of the suppliers along the LMS development road map are represented in figure 3. It is evident that the competence level of Supplier 2 is less than that of Supplier 1, as it did not have any prior experience in manufacturing of filter cages. The similar conclusion is made for the infrastructure element. Both suppliers met all the social and location criteria required from Howden. The lower scoring of Supplier 2 in the economic element was mainly due to its manufacturing readiness level. The competitiveness score for each supplier was relatively high. This is because both suppliers already had quality control procedures and systems in place and both their BBBEE ratings met the requirements from Howden Africa. The outputs of typical models illustrated in figure 3 show that Supplier 2 had the lowest possibility of conforming to the required specifications and would incur a greater required investment to improve on their compliance. Howden Africa predicted to spend an average R5million per annum on cages. The heat map for the value add to the community shows that both suppliers would contribute positively as both have a high level of employment from the local community. The percentage of local ownership of each supplier was also relatively high in this regard. This is evident in the BBBEE rating of each

supplier although Supplier 1 has a rating of 1 whereas Supplier 2 have a lower rating of 2. This means that 135% of the procurement spend on Supplier 1 contributes towards Howden Africa's BBBEE scoring whereas only 125% of its spend will be recognised with Supplier 2.



Action Plan for Local Manufacturing Supplier Development

Priority	Key Focus Areas	Life cycle element of LMS	Compliance %	Suggested Options to consider	Investment required
1	Manufacturing and operational Skills	Competence Element	50%	Training Support Programmes, Incubators, Shadowing etc.	R 60 000.00
2	Equipment & tools	Infrastructure element	75%	Establish Funding mechanisms, gifting, cluster, Joint co-operation etc.	
3	Facility and supporting infrastructure	Infrastructure element	75%	Establish Funding mechanisms, gifting, cluster, Joint co-operation etc.	

Figure 3: Outputs from model (Action plan for Supplier 1) – for illustrative purposes only

It was evident from the decision support tools of the model that Supplier 1 would have been chosen as the best-suited supplier to develop further. The overall outputs of the model including the action plan for the recommended supplier 1 are represented in figure 3.

3. Conclusion

In order to grow the local economy organisations need to start supporting local manufacturing suppliers (LMS's). The problem organisations still face is to effectively determine the maturity level of a LMS in conjunction to the organisation's required technological or capability requirements. The objective of this paper was to develop a strategic local manufacturing supplier development roadmap as a decision support tool. The roadmap illustrates four phases of the required development of a LMS to ensure its sustainability. Each phase has certain key elements that

need to be developed, before the LMS can progresses to the next stage. These stages are social and educational, infrastructure and technology, business security and longevity and integration. The first two phases constitute the capability building of the LMS which forms part of the informal business development of the LMS. The second two phases form part of the formal business development of the LMS categorised as supply and demand. A mathematical model was created to quantify the actual conformance of a LMS to each key element along the development stages of the roadmap. Further decision support tools are incorporated into the model together with an action plan to focus on the key required development areas of a LMS depending on where it lies on the roadmap. The various supporting functions, funding mechanisms and stakeholders that arise along the development stages of a LMS have been incorporated into the framework. This allows the action plan to suggest possible solutions to the shortcomings of the LMS for various required criteria. The outputs to the model include; an action plan to develop LMS (detailing which requirements the LMS needs to be developed on, with suggested possible funding structures or support); heat maps illustrating the comparison of various suppliers based on the investment vs. reward (transformation and value add to local community), the calculated position of the LMS on the development road map and a project management plan for developing the supplier. The developed roadmap determines the foundational requirements for an LMS to ensure its development along the prescribed phases, where various funding mechanisms or supporting structures have been allocated to each phase to assist in the development. The phases and the application of various funding and support mechanisms, along these phases, where empirically proven in this research to assist in local supplier development.

References

[1] Kaiser Economic Development partners, "An approach to defining, measuring and monitoring local procurement by the mining industry," in *World bank local Content Conference*, Vienna, 2013.

[2] R. Dodge and J. Rabbins, "An Empirical Investigation of the Organizational Life Cycle Model for Small Business Development and Survival," *Journal of Small Business Management,* pp. 27-37, 1992.

[3] S. H. Hanks, C. J. Watson, E. Jansen and G. Chandler, "Tightening the Life-Cycle Construct: A Taxonomic Study of Growth Stage Configurations in High-Technology Organizations," *Entrepreneurship Theory and Practice,* pp. 5-29, 1993.

[4] K. Van Montfort, "Life cycle characteristics of small professional service firms," *Journal of Small Business Management,* pp. 417-438, 2006.

[5] Porter and Kramer, "Strategy & Society: The link between Competitive Advantage and Corporate Social Responsibility," *Harvard Business Review,* pp. 78-93, 2006.

[6] J. Welsch, Jack Welsch, St Ives. Great Britain: Headline Book Publishing, 2001.

[7] T. London, "The base-of-the-pyramid perspective: A new approach to poverty alleviation," in *Proceedings of the sixty-sixth annual meeting of the Academy of Management*, 2008.

[8] C. Prahalad and S. Hart, "The fortune at the bottom of the pyramid," *Strategy and Business,* vol. 26, no. 1/4, pp. 2-14, 2002.

[9] K.-H. Lee, "Why and how to adopt green management into business organizations?: The case study of Korean SMEs in manufacturing industry," *Management Decision, 47,* pp. 1101-1121, 2009.

[10] Y. A. Fatimah, W. Biswas, I. Mazhar and M. N. Islam, "Sustainable manufacturing for Indonesian small-and medium-sized enterprises (SMEs): the case of remanufactured alternators," *Journal of Remanufacturing,* pp. 1-11, 2013.

[11] R. Hillary, "Environmental management systems and the smaller enterprise," *J Clean Prod,* pp. 561-569, 2004.